Life Science Technologies

This site contains the student study guide for the master’s programme with materials and instructions on all the majors available in the programme. Here you will find the programme curriculum as well as detailed guidelines for planning your studies.

Technological innovations have become an essential part of modern healthcare, well-being and bioeconomy. Therefore, both in academic research and industry there is an increasing need for people who can deal with today's increasingly complex biomedical problems.

Master's Programme in Life Science Technologies offers a multidisciplinary curriculum focusing on important aspects of current biomedical research, covering fields such as biological data analysis and modeling, advanced biomaterials and bioelectronics, biomedical engineering and neuroscience. The program draws on fundamental and applied knowledge on these fields and is closely linked to research conducted in the participating Schools and Departments.

The programme offers majors for specializing in Bioinformatics and Digital Health, Biomedical Engineering, Biosensing and Bioelectronics, Biosystems and Biomaterials Engineering, Complex Systems, and Human Neuroscience and Technology, with possibility to combine different fields with minor and elective studies.

- **Bioinformatics and Digital Health**
  - Bioinformatics is a young field of science that seeks answers to the rich research questions in biology, medicine and biotechnology, with computational modeling of biological systems, and the analysis of complex big data produced by modern high-throughput measurement technologies. Understanding such data requires robust statistical modeling and computationally efficient methods. The Bioinformatics major in the Life Science Technologies programme is designed to give a strong competence in computational and data science, in particular skills for developing new computational methods and models, and applying them to real world biomolecular data. Robust background in probabilistic modeling and machine learning is provided, as well as skill to interpret and visualize diverse biomolecular data. Computer practicals are part of most courses ensuring understanding of both theory and practice of the methods. Biological background can be broadened with an elective minor. State-of-the-art methods for analyzing next-generation sequence data, gene expression and 'omics data as well as biological networks are part of the curriculum. Examples of research questions studied include predicting drug-target interactions, reconstruction of biological networks, finding associations between genotypes and diseases, and modelling dynamical behavior of complex biological pathways. The high number of biological research groups (100+) in Helsinki region provide good opportunities for internships and thesis work in real environment. International mobility period can be accommodated to the degree. Honours programme is available for high-performing students, giving a possibility to work part-time in a research group during the MSc studies. Good opportunities for PhD studies exist for excellent graduates of the Bioinformatics major.

- **Biomedical Engineering**
  - Biomedical engineering builds on a solid basis of physics and technology to characterize, monitor, image and influence biological systems. This major introduces the student to the physics of biological systems in order to efficiently measure, image, and model such systems. In addition, it provides the student with basic knowledge and skills needed for developing novel engineering solutions for diagnosis and treatment in health care. The major offers excellent foundations for pursuing a career in biomedical technology industry or in academia. After completing the major, the student will be able to characterize biophysical systems by conceptual and quantitative models explain how the laws of physics enable and constrain the operation of biological systems follow the progress of biomedical engineering deepen his/her knowledge and skills of specific topics within biomedical engineering apply existing scientific knowledge of the field to research and development in the industry start translating new research results into product development in biomedical technology.

- **Biosensing and Bioelectronics**
  - The major in Biosensing and -electronics combines both theoretical and practical studies in designing, developing, fabricating and characterizing biosensors, biomedical devices and medical instrumentations. Hands-on experience is gained in order to understand the biocompatibility of both organic and inorganic materials used in electronics, as well as interactions between low frequency electromagnetic fields and living tissue, and in special applications these interactions even with single cells and biomolecules. The target is to educate engineering experts, who have versatile comprehension of biosensors and other electronic applications. To accomplish this, the student is introduced to nanoscale phenomena, microfabrication techniques, biomaterials science, biochemical recognition of biomolecules, physical transducers, sensor technologies and to a good extent also to clinical equipment like medical imaging. The tools needed in the development of innovations in the field of biosensors and bioelectronics are provided and the students are strongly encouraged to commercialize their own ideas.

- **Biosystems and Biomaterials Engineering**
  - Graduates in Biosystems and -materials major receive a broad training and in-depth knowledge, combined with practical experience. The major provides a solid understanding of biological phenomena, biomaterials and small organic molecules important to the field of Life science. At the core of the teaching are the understanding of molecular and cellular level phenomena, reprogramming of cells, molecular design and characterization of small pharmaceutically active molecules, and the synthesis and characterization of biomaterials. Specialization during the major allows acquiring in depth understanding in one of the selected fields or studying at the interface of the different fields. The core contents focus on:
    1. Structure and function of biomolecules in pro- an eukaryotic cells with respect to major metabolic pathways, cell energetics, physiology and regulatory pathways at the molecular level and interactions of biological molecules. Enzyme structure and function, enzyme catalysis and thermodynamics of biological systems.
    2. Cellular physiology and its adaptation to different stimuli from the molecular to cellular level using transcriptomics, proteomics, metabolomics including modeling of complex systems.
    3. Engineering of cellular systems including tissue engineering, stem cells and use of genetic engineering and synthetic biology for
programming of cellular circuits, pathways or designing of bio-based materials, regulatory requirements and principles of Good Manufacturing Practice (GMP).


5. Colloid and surface science of biological materials, surfaces of materials as an interface to biology, interactions of inert and bioactive compounds (scaffolds, implants, wound dressing, etc) with biological systems.

6. Pharmacologically active compounds derived from small molecules and natural biomacromolecules from the viewpoint of molecular interactions. Drug classes, based on both disease types and chemical structural classes, are discussed.

7. Use of mass spectrometry (MS), infrared spectroscopy (IR) and nuclear magnetic resonance spectroscopy (NMR) in the structural determination and identification of organic compounds

The major is strongly research driven and is tightly linked to research activities related to the fields of biotechnology, organic chemistry, chemical and biological microdevices, and polymer science at the School of Chemical Technology. Employment sectors for graduates are within the broad context of engineering combined with chemistry and biotechnology within the pharmaceutical and medical technology industries.

**Complex Systems**

The Complex Systems major will provide students with tools to understand systems with large numbers of interacting elements, from the human brain to social networks and from living to technological systems. This major will focus on system-level understanding as well as on giving the students hands-on experience in data-intensive research. The set of tools in the curriculum includes network science, nonlinear dynamics, agent-based modelling, machine learning and Bayesian statistics, together with the fundamentals of dealing with empirical data and computational data analysis. This interdisciplinary major is suitable for students from different backgrounds (e.g. physics, bioinformatics, computer science), and students can choose to put emphasis on computational data analysis, theory, or application areas, according to their own wishes.

**Human Neuroscience and Technology**

The Human Neuroscience and Technology major comprises 60 ECTS credits. The aim is to give the students a strong background for understanding functions of human brain and mind, as an integrated unit. After their studies, the students have excellent possibilities to go on in relevant PhD studies, as well as to start working in more applied fields outside academy.

The emphasis of the curriculum is experimental. Although regular lecture and course work is also required, much of the studies will take place in small groups under the guidance of a senior scientist. Students will be learning in the laboratories of the School of Science, where top-level research is being conducted.

The major is liberal arts spirited in a sense that it imparts general knowledge and develops the student's rational thought and intellectual capabilities, unlike the professional, vocational and technical curricula that emphasize early specialization. Scientific writing and presentation skills receive special emphasis in the programme. The curriculum is a carefully tailored combination of modern systems-level research methodology of the brain, mind, and human cognition, signal and computational analysis and modelling methods.